

Industrial Complex Transformation Trends in Digital Economy

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Abstract — The article considers the relevant trends and problems of the Russian manufacture transformation under the digital economic context. The feature of the digital economy is determined that is implied the wide use of information and communication technology (ICT) and digital transformation as enterprise formation resources. An analysis of ICT introduction is carried out by the Russian manufacturing industries. An asymmetry problem in the digital transformation of the manufacturing complexes is revealed which is a high level of ICT using in financial, logistic and marketing spheres and a low level in industrial area. The risks are denoted that specified imbalance can be an obstacle for creation efficient digital platforms and introduction elements “Industry 4.0” on the manufacturing enterprises. It is determined that the Russian industry falls behind the digitization indicators of the productive sectors of the world’s developed economies. A way to reduce the digital gap of domestic companies from foreign competitors is proposed, which provides for balanced reforms of industrial enterprises that combine measures of active digital transformation with structural and managerial, cultural, functional and other changes. The trends of industrial complex transformation in the digital economy that are common for Russian and foreign countries are revealed: 1) the transformation of enterprises into cyber-social economic systems that ensure a deep integration of human and machine potential in solving production, analytical and other tasks; 2) the management quality improvement by implementing data mining tools and supporting to management decision-making; 3) creation of digital platforms as key assets of industrial complexes; 4) transition of enterprises to project models of work, including through the creation of self-regulating cross-functional teams; 5) use of flexible business processes that ensure the adaptation of enterprises to the constantly changing environmental parameters; 6) strengthening the competitiveness of companies by increasing the innovation activity of staff and optimizing the R&D cycle. It is proved that one of the most important factors of effective transformation of industrial

complexes in the digital environment is the involvement of personnel in the transformation processes.

Keywords — *change trends, transformation of enterprises, a digital transformation, digital economy, information and communication technologies, industrial complex.*

I. INTRODUCTION

The formation of digital economy is a global and sustainable trend that will lead to a significant renewal of the mechanisms of commercial activities by industrial enterprises and complexes.

In 2018, the consulting company PricewaterhouseCoopers, together with the British Institute Oxford Economics, conducted a survey of the global business community (2.3 thousand respondents from 60 countries) on the development of the digital economy. The results of the study showed that more than 30 % of business executives see a threat to their business in the market changes that occur under the influence of digital innovations [1]. The concerns of business sector representatives are caused by the fact that dynamic digitalization creates not only new opportunities for enterprises, but also creates a hyper-competitive and high-risk market environment that determines the need for a deep and comprehensive transformation of the operating models of industrial companies.

Digital economy is a system of economic relations, the most important factor in the formation and development of which is the use of information and communication technologies and data mining tools by market participants in the processes of creating, selling and consuming goods, works, and services.

The peculiarity of digital economy is that digital technologies and innovations take on the role of enterprise-forming resources, which largely determine the structure and business models of industrial organizations. In addition, digital tools and services create technological opportunities for dynamic productivity growth and lower transaction costs.

According to the McKinsey consulting group, the economy digitalization can ensure the growth of Russia's GDP by 4-9 trillion rubles by 2025. The following areas of digital transformation of domestic enterprises and markets can be potential sources of increasing the country's GDP:

- improving the efficiency of production operations and logistics processes (the expected financial effect for GDP growth is 1.5–4 trillion rubles);
- optimization of the personnel movement system and staffing support of the economy (effect – 2–3 trillion rubles.);
- improving the quality and performance of equipment (effect – 0.5-1.5 trillion rubles.);
- reducing the duration and increasing the efficiency of research and development cycles (effect – 0.2–0.5 trillion rubles);
- reducing production losses and reducing the material intensity of the technologies used (effect – 0.1 trillion rubles) [2].

Achieving the above financial results is possible only in the case of an inclusive and comprehensive reform of the Russian industry, combining measures of digitalization, technological modernization, structural and functional redesign and development of the management culture of industrial enterprises and complexes.

II. METHODOLOGY AND ANALYSIS

The purpose of the article is to identify and analyze trends in the transformation of industrial complexes in the digital economy. The research goal is achieved by *solving the following tasks*: 1) justification of the feasibility of carrying out transformations of domestic industrial companies; 2) analysis of the current level of digital transformation of industrial complexes and enterprises; 3) identification and description of transformation and development trends of production enterprises in the digital environment.

The object of the study is industrial complexes and large industrial enterprises, as well as the economy as a whole. *The subject of the research* is organizational and economic tendencies and trends in the sphere of enterprise transformation, caused by the development of the digital economy and the spread of digital innovations.

The research toolkit includes methods of comparative, statistical, sociological, structural, and descriptive analysis, as well as systematic and logical approaches. *The analysis information base* consists of data from reputable consulting and research structures (McKinsey, PwC, Oxford Economics, Gallup Institute), as well as official statistical indicators.

The theoretical and methodological basis of the research is the specialized scientific works of N. Negroponce, R. Buchta, R. Higgs [3], D. Tapscott [4], S. Sharma, Hamari [5], A. E. Karlik, V.V. Platonov, N.O. Zaruchnikova, V.V. Glukhov [6], Yu.A. Salikov, I.V. Kablashova [7], N.A. Serebryakova, I.V. Avdeev [8].

Researches by GC “Zyfra” and the Russian Ministry of industry and trade show that the management of Russian enterprises is fully aware of the relevance and high importance of digital transformations. However, only about 60 % of domestic industrial complexes and large industrial enterprises have a clear program of digitalization [9].

The Russian Industrial complexes and enterprises are actively implementing information and communication technologies and are ahead of the average values for the domestic economy for most ICT indicators (TABLE I). At the same time, compared with the European Union countries, the digitalization level of Russian industry is low and lags behind by 50–55 % [10].

An analysis of the presented data shows that from a structural point of view, the digital transformation of Russia's industrial complexes has been uneven. On the one hand, almost all businesses are connected to the Internet and use hardware and software to implement financial and logistics functions. On the other hand, companies' production subsystems (equipment, machines, etc.), which are key elements in value chains remain at the initial stage of digitalization. This is largely due to the fact that in Russia the share of machines with numerical control (CNC) is only 10 %, and about 90 % of the production equipment is not interactive, does not accept or transmit any information [2, 9].

This situation creates risks that the supporting processes and auxiliary functions of Russian enterprises (finance, marketing, logistics, communications, etc.) will be digitized quickly enough, and the digital transformation of production will be significantly delayed. This can create imbalances in the level of technological development of various subsystems of industrial complexes and act as an obstacle to the organization of effective digital platforms and the introduction of elements of “Industry 4.0” in the domestic industry.

The management of companies sees the solution to this problem in updating the machine park. About 80 % of the Russian industrial enterprises plan to upgrade their equipment in the medium term. According to the estimates of GC “Zyfra”, only equipping with monitoring systems of all CNC machines used in Russia can give a positive economic effect in the amount of 660 billion rubles [9].

It should be noted that the scale of use of information and communication technologies and the resulting financial impact are important, but not the main indicator of the successful transformation of Russian enterprises. For example, some PricewaterhouseCoopers analysts note that “digitalization is not just about IT, nor is it about individual efficiency initiatives. It is a special worldview and approach to work [1]. Currently, about 70 % of industrial complexes that are actively transforming their business model believe that their investments in digital technologies have not met the

expectations. They explain this problem by the fact that ICT and digital innovations have not become a full-fledged element of their corporate strategy and reform plan [1].

TABLE I. SEPARATE DIGITALIZATION INDICATORS OF THE RUSSIAN COMMERCIAL SECTOR [11]

Used information and communication technologies	The commercial sector as a whole, %	The manufacturing enterprises, %	The difference, pp.
Connecting organization to the broadband Internet	86	90.3	+4.3
Providing staff with mobile devices for Internet access	45.5	50.2	+4.7
Online procurement	20	21	+1
Sales organization via the Internet	15.4	19.6	+4.2
The use of cloud services	27.1	26.2	-0.9
The use of RFID technology	6.8	11.4	+4.6
The use of software to:			
- conducting financial settlements	57.7	66.6	+8.9
- solve organizational, managerial and economic problems	57.3	64	+6.7
- manage of automated production and / or individual technical means and processes	16.7	n.d.	---
- for design	13	n.d.	---
- for scientific research	4.5	n.d.	---
- access to network databases	31.1	27.7	-3.4
The use of automated control systems (in logistics, communications, etc.):			
- ERP-systems	21.6	27.6	+6
- CRM- systems	17.6	17.3	-0,3
- SCM- systems	10.1	6.7	-3.4
Digital signature application	74.6	82.5	+7.9
Availability of production equipment with numerical control	n.d.	<10	---

In digital economy, the development and transformation of industry should not be reduced solely to the automation and informatization of industrial companies. Conducting transformations requires an integrated approach and implementing balanced changes in all areas of production enterprises – in strategies, values, management culture, content of functions, logic of business processes, and models of organizational structures.

The validity of the above conclusion is confirmed by the practice of transformation of the largest foreign and domestic companies: Cisco, Alcoa, HP, General Motors, General Electric, Boeing, VASO, PJSC “Severstal”, PJSC “Sibur Holding”, and PJSC “Kamaz”. These companies are fundamentally rebuilding their business models, taking into account the socio-economic characteristics and trends of the digital environment. Their strategies are not limited to a systematic implementation of ICT, but are based on parallel and synchronized implementation of managerial, structural, digital and other transformations. This allows getting a powerful synergistic effect, which is expressed in an "explosive" growth of labor productivity, system innovation activity and increasing the efficiency of business processes.

III. DISCUSSION AND RESULTS

The research of the scientific and theoretical base on the transformation of enterprises, as well as taking into account the practice of reforming industrial companies, allows forming the logic and determining the transformation trends of industrial complexes in the digital economy (Fig. 1).

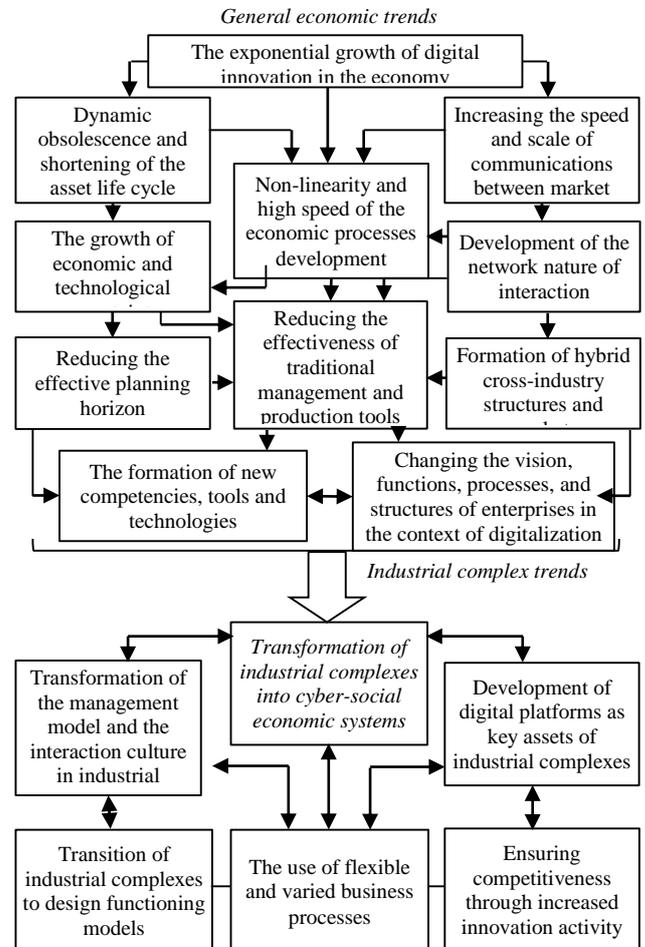


Fig. 1. Logic and trends of the transformation of industrial complexes in the digital environment

Among the key trends in the transformation of industrial complexes in the conditions of formation of the digital environment, the following facts can be identified.

1. Transformation of industrial complexes into cyber-economic systems, in which a deep integration of human and machine potential (including intellectual) is provided for the effective implementation of business processes [12]. At the same time, the space for combining personnel and production assets is not so much the physical territory of the enterprise as a single digital environment. This cooperation is possible due to the development of the industrial "Internet of things" and elements of "Industry 4.0", which actually give subjectivity to the equipment and make it a full participant of the management system of industrial complexes (with the possibility of making independent decisions, provided for by the software).

2. Transformation of the management model and the personnel collaborative culture at industrial complexes. In 2016, after visiting Stanford University and Silicon Valley enterprises, the President and Chairman of the Board of Sberbank G. Gref expressed the following idea – “in fact, there is no competition for goods, products or services. There is a competition between management models. And this is the main conclusion. We can reproduce anything we want, but we can only win through a more effective management system that includes, perhaps first of all, the aspect of culture.” In the digital economy, the quality of management and the speed of decision-making become crucial, since the development of industrial complexes is carried out under uncertainty and high dynamics of market changes that occur under the influence of digital innovations. The management and specialists of enterprises face the challenges of constantly adapting their business to the changing market, developing a methodology for solving new non-standard issues, developing effective strategies for maintaining competitiveness and effectively managing cross-functional hybrid structures.

Addressing the above tasks is accompanied by the following main changes in management models and the culture of personnel production interaction:

- dynamic digitalization of industrial complex management processes and the use of artificial intelligence technologies, machine learning, neural networks and other high-tech digital tools to support management decision-making;
- active implementation of methods and technologies into the industrial complex management system aimed at reducing transaction costs and increasing labor speed and productivity;
- development of interagency teams and project working groups at the Institute's enterprises that ensure accelerated development and implementation of innovations;
- increasing the values status of innovation activity, self-organization and self-management of personnel in the corporate culture of companies; involvement of personnel in the processes of ongoing institutional transformations.

3. Development of digital platforms as key assets of industrial complexes. At its core, digital platforms are flexible intelligent information and analytical systems that integrate personnel, technologies and resources of production companies, as well as subjects and elements of their external environment (suppliers, contractors, clients, etc.) into a single high-performance project [13]. Digital platforms make it possible not only to provide automated design, execution and regulation of business processes of the industrial complex, but also actively use data mining methods to improve the quality of management and the speed of making various decisions. Thus, the digital platform serves as a tool for building a seamless, dynamic and structured process of creating added value, which covers all its participants, minimizes transaction costs, significantly increases labor efficiency and does not

have barriers and gaps caused by traditional problems of interdepartmental and interstructural interaction.

4. Transition of industrial complexes to design functioning models. Due to the constant market changes and the reduction of periods between bifurcation points in the economy, the process of creating added value in industrial complexes will become more discrete, nonlinear and anti-persistent (weekly dependent on the previous development trajectory). In these conditions, the process approach to business organization and management that dominates in the domestic industry will lose its relevance, and the project approach focused on dynamic, customized and time-limited production cycles will replace it. Cross-functional teams of highly qualified specialists of the enterprise who use the principles of AGILE methodology, SCRUM method, Kaizen production philosophy, Kanban systems, lean manufacturing technologies and others can be an effective tool for organizing personnel for solving project tasks [13].

5. The use of flexible and variable business processes that provide a high level of enterprises adaptability to dynamically changing environmental parameters and allow quick adjustment of the development strategy in case of sudden changes in the market. Flexibility is the most effective tool for maintaining the manageability and stability of the industrial complex under uncertainty. In the digital environment, the ability to quickly adjust operational priorities and rebuild interaction algorithms becomes a necessary requirement for the operation of enterprises.

6. Ensuring competitiveness by increasing innovation activity. The development and implementation of innovations allows maintaining a positive balance of technological development between the industrial complex and the market, as well as constantly and systematically improving the company's business model by using the latest achievements of scientific progress. According to the position of A.E. Karlik, an important direction for the transformation of industrial complexes will be the stimulation of organizational innovations in combining physical and intellectual capital based on the use of digital technologies [12].

It should be noted that the most important condition for the effective and successful transformation of industrial enterprises in the digital environment is the involvement of personnel in the transformation processes. According to the former General Director of General Electric, J. Welch, “the involvement of each individual employee in the work, the recognition of their contribution to the final result, and the recognition of the right to have a voice and a role in achieving the success of the company is the source of true productivity. The source allows increasing it not gradually but at times” [14]. Studies of many sociological, consulting, and analytical companies (for example, Hewitt Associates, Hay Group, and American Institute of Public Opinion) clearly show that the prevailing part of enterprise transformation projects is unsuccessful due to the low involvement of their management and employees in implementing reforms. At the same time, those companies that effectively use their human resources, dynamically transform and develop, quickly become market leaders and achieve high financial results. According to a

Gallup Institute study, their profits are on average 22 % higher than the industry average [14, 15].

IV. CONCLUSION

The digital transformation of economy is of dual importance for the development of industrial complexes. On the one hand, it opens up additional technological opportunities, increases labor productivity, makes communication between sellers and buyers more accessible, stimulates innovative business activity, and eliminates market barriers. On the other hand, digitalization generates a significant amount of risks, including the rapid obsolescence of technologies, the destruction of traditional industries, the dynamic appearance of substitute products, and the growth of economic instability.

In the new market realities, the prospects for the development of industrial complexes will completely depend on the chosen strategy of action. Enterprises that follow the path of active institutional changes will be able to use the available opportunities and strengthen their competitiveness. But those organizations that choose an inertial operating scenario and do not implement reforms will eventually lose their positions in the market.

Currently, Russian industry lags behind the industrial sectors of the world's leading countries in terms of digitalization. The key tool for reducing the "digital divide" between domestic and foreign companies is not so much the intensification of the use of information and communication technologies by Russian enterprises, as the implementation of systemic changes in their business models, combining measures of organizational, economic, innovative and digital development.

The proposed trends in the transformation of industrial complexes show that in the digital economy, the priorities for the development of industrial companies will be improving the management quality, ensuring the flexibility and variability of business processes, creating the digital platforms, optimizing the content and composition of implemented functions, implementing project forms of personnel organization, using innovative technologies and methods of work, and forming values of self-organization and experimentation in production teams.

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